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Interak 1

CP/M 80
DOS

CP/M 2.2 Disk Operating System

FEATURES

* Version 2.2
* Serial or Parallel Operation.
* Configurable by User, but supplied in a "ready to run" minimal configuration.
* Easily Altered for Differing RAM sizes.
* "Mixed" drives sizes possible, eg 8" and 3.5".
* Easily configured for 1, 2, 3, or 4 drives.
* Drive stepping rate adjustable. (5 rates available, 3ms to 30 ms).
* Up to 4 drives of any two types.
* Special 1 drive mode for single drive systems.
* I/O byte implemented.
* Paper tape reader and punch implemented as magnetic tape cassette.
* Provides access to 1000's of "Public Domain" programs.
* Supplied with complete Digital Research original documentation.
* Available for 3.5", 5.25", 8" diskettes.
* Full suite of Digital Research Programs included (eg 8080 Assembler, DDT debug program, etc.).
* Additional non-Digital Research programs included (eg FORMAT.COM).
* Works in minimum 20K RAM system (larger RAM recommended).
* One version to work with any of the DMON monitors.
* Standard 512 byte sector double density disk format.
* Full 10 (ie not 8 or 9) sectors on smaller diskette sizes.
* 4K Block Size on smaller diskette sizes.
* Two reserved system tracks.
* Utility provided to read standard 8" IBM 3740 128 byte sector disks.
* Single or double sided disks.
* Requires FDC-1 Interak Disk Interface Card.
* Provides write enable precompensation even for the smaller diameter disks.
* As supplied allows up to 128 directory entries.

CP/M 2.2 Disk Operating System

DESCRIPTION

CP/M-80 is a disk operating system. An operating system is the collection of programs which together control all of the resources of the computer. For example, when any program which is running needs to access the disk, printer, screen, etc., it passes the request to CP/M, which has control of those resources. As a user, writing your own programs, you too can (and should) call any of these given routines to save you the effort of writing your own, and to make your programs "portable". CP/M is particularly well designed because it has been organised in such a way that only a special part (the BIOS, ie the basic input output system) needs altering if the hardware is changed, everything else remains the same. In theory (and substantially in practice too) a computer using CP/M-80 can run any program from any other CP/M-80 computer, provided certain conventions are followed, and of course providing no use is made of a resource which is not present on both computers.

Pandora's Box

CP/M was one of the first operating systems to gain almost universal acceptance. Once you knew CP/M on one machine, you knew all about CP/M on all the rest. If you changed your hardware, eg, numbers or sizes of disks, VDU changes, etc, you could simply change the BIOS part of CP/M and old software would still run. It was easy to move programs from one machine from another, and gain access to vast pools of "public domain" programs. Because CP/M is such an open system, protection against copying, disassembly of programs, and so on is virtually impossible. The software industry had opened what was to them a Pandora's box. CP/M was wonderful for the spread of knowledge, data and programs freely from one user to the next, but anathema to those who wanted (for their own selfish business reasons) to keep it all secret. However now the secret is out it is out. (But they won't make the same "mistake" again.)

Propaganda

The plan nowadays seems to be that the big guns in the computer industry should continually keep bringing out newer and slightly different disk operating systems and hardware and make sure each is incompatible with the last, so that to stay up to date the user has to buy a new computer and set of software every couple of years ("planned obsolescence", as practised with great success for years in the motor car industry).

As far as CP/M is concerned, all that the big guys can do now is fight a rearguard action; gradually kill CP/M by making its existing users dissatisfied with it, call it funny and old-fashioned and perhaps everyone will throw it away. In our case we are not going to fall for this propaganda - we have been happily using our Word-processor (including the preparation of this very document) on our own Interak CP/M machine for several years now, and intend to carry on using it for many years more, so why should we throw it all away just to suit the convenience of someone who wants to sell us something new?

Pundits

Rather unfairly CP/M has been criticised by the pundits (writing in the computer magazines, not that this means they necessarily know what they're talking about) as being "user unfriendly". Certain of the utility programs (eg ED.COM, the line by line editor) included as utilities with CP/M can with some justification be so described, but this is only a criticism of that program, not the operating system! Consider "Wordstar", with its built in automatic help messages: That runs under CP/M and is a particularly user friendly package. If he runs competently written applications programs the user need never be aware even of the existence of the operating system unless he wants to dig deeper, which is just as it should be.

CP/M is the ideal disk operating system for Interak. It is based on the same concepts as Interak: it is efficient, robust, well established, not slated for imminent obsolescence, widely understood, and so on. Like Interak, CP/M will never die, no matter how fashions change.

The precise version of CP/M we use is CP/M-80 Version 2.2. The "-80" simply means that it suits microprocessors such as the 8080, 8085, Z-80, the new HD 64180 (enhanced Z-80), and the like, and "Version 2.2" is an enhancement of the earlier Digital Research Version 1.4 (cynics will say that the only difference in Version 2.2 is that it costs twice as much as Version 1.4. However Version 2.2 represents Hobson's choice for us, because the earlier version is no longer available from Digital Research).

(We are actively looking into the possibility of implementing yet another variant of CP/M, called CP/M plus. This costs more and offers some useful extra features, however, much has been taken away, for example there is no MOVCPM utility or equivalent; it requires more memory and hardware complexity than does version 2.2 to give the present level of performance, and it has other disadvantages from the purely "systems" point of view. So for the time being at least CP/M-80 2.2 is the most useful version.)

Not Stripped Down

Needless to say our CP/M is the real McCoy, and includes all which should be included. There have been a few instances of other suppliers offering CP/M but in a stripped down form. For example they have omitted the detailed Manuals written by Digital Research, which reveal all about CP/M and what goes on inside; without information like this you cannot attempt to modify and understand it yourself should you ever need to. Because of the fear of unauthorised copying of CP/M, Digital Research will not supply the Manuals on an individual basis, so without them you're sunk. Similarly, the rogues who prey on the innocent omit many or all of the essential utility programs which are part of the normal CP/M package.

Those of us who have had experience of some of these, eg ED.COM, the Editor program, might be unkind enough to say that this hardly matters because at least it saves you the effort of throwing it away (it is so awful to use), but that is not the point - if you buy CP/M you are entitled to the full set of utilities. Other items which we supply as part of our package, which of course are not available from any other supplier of CP/M, are some detailed instructions of our own, the Interak BIOS already installed, and on the disk numerous extra files which we think will have usefulness and relevance to an Interak user.

Menu

Provided the system has a working DMON monitor, at least one disk drive (single or double sided) and at least 20K of RAM, the CP/M disk we supply will run immediately. In the CP/M application the instruction is included to switch off the DMON EPROM itself (therefore allowing up to a full 64K of RAM), and this can also be done in the user's own programs if he wishes.

One of the programs on the disk is called CONFIG, and after you have made a backup copy of the master disk we supply, you run CONFIG to tailor the system to suit your needs, eg number of disk drives, single or double sided, number of tracks, printer port number, serial VDU or memory mapped VDU etc. The common configurations are handled by menu choices in the CONFIG program, but more advanced requirements may be satisfied by the knowledgeable user in employing the file we supply called USER.ASM, which gives the source code of the user-modifiable part of the BIOS. Modifications to the "User" part of the BIOS can be made with the aid of the DMON Disk Boot/Monitor and/or the "DDT" and "ASM" programs supplied in the normal CP/M package.

Examples of modifications to the BIOS which can thus be made by the user are as follows:

Different VDUs (eg VDU-2K or Serial Terminal).
Different Keyboards (eg Parallel or from Terminal).
Different Diameters of disk, and mixed diameters within the same system, eg three 3.5" + one 8".
Different Densities, ie single/double, even mixed within the same system.
Different stepper motor rates (Disk head stepper).
Different numbers of tracks, sectors etc.
Different hard and soft skewing (sector interleaving) methods.

Public Domain

Although double density working is used throughout the Interak system, there is one circumstance where the ability to operate in the old single density mode is essential, and that is to allow the user to read and write "IBM 3740" single sided single density disks assuming a sector translation (Skew) factor of 6. This is because this is the one disk standard which has been accepted by everybody, and therefore is the one on which 8" software is purchased, sent from one user to another, and "public domain" software obtained from the CP/M user group libraries. All systems will therefore be supplied with a utility to allow this format to be written or read. (The IBM 3740 8" format is single sided 77 track 48 tpi 26 sectors per track, 128 bytes/sector.)

Files

The following list gives details of the files on the CP/M master disk in the form in which we supply it.

(1) As supplied by Digital Research, with minor bug fixes were appropriate, (as published in CP/M newletters and the like):

ASM.COM	Digital Research's 8080 Assembler.
BIOS.ASM	Source Listing of Digital Research's BIOS.
CBIOS.ASM	Source Listing for Digital Research's Skeleton BIOS.
DDT.COM	Digital Research Dynamic Debugging Tool.
DEBLOCK.ASM	Source listing for Digital Research's Disk sector deblocking algorithm.

DISKDEF.LIB	Digital Research disk definition tables.
DUMP.ASM	Source of program to view or print out the contents of a disk file.
DUMP.COM	Above dump program ready to run.
ED.COM	Line by line text editor.
LOAD.COM	Program to Load a disk file in Intel Hex format in a form in which it can be run and/or saved.
PIP.COM	Peripheral Interchange Program. Used for moving and changing data and programs between the available peripherals.
STAT.COM	Digital Research "Statistics" program, allowing the state of various controls to be examined and/or changed.
SUBMIT.COM	Digital Research program to allow batches of commands to be executed without operator intervention.
XSUB.COM	Extended version of SUBMIT.COM.

(2) As supplied by Digital Research, but with extensive changes to suit the Interak environment and make the programs behave as Digital Research originally intended:

CPM20.COM	Interak CP/M, loadable under DDT (qv).
MOVCPM.COM	Interak version of Digital Research program; allows the user to alter the size of his CP/M system and incorporate modifications set by running the "CONFIG" program.
SYSGEN.COM	Interak version of the Digital Research program. Used to allow fresh copies of the CP/M system to be generated by the user.

(3) Programs not supplied by Digital Research in any form. These are simply bonus programs included on the disk for the benefit of Interak Users.

CONFIG.COM	Interak Configuration Program.
COPYDISK.COM	Interak disk copying utility.
COPYFILE.COM	Interak file copying utility.
CPMMAP.COM	Utility to display key CP/M addresses.
DISKMAP.COM	Utility to display map of used sectors on disk.
FORMAT.COM	Interak disk formatting program.
MEMMAP.COM	Utility to give a map of available system memory.
PRINT.COM	Utility to allow long printouts to be executed without losing the use of the computer.
SETB8SD.ASM	Source Listing of program to set drive B (if available) to read standard IBM 3740 format single density 8" disks.
SETB8SD.COM	Executable form of above program.
SPEEDTST.COM	Utility to allow user to determine optimum skewing factor.
USER.ASM	Source Listing of all the user modifiable parts of the Interak BIOS.

Pennies

The SYSGEN Program has been modified so that it will operate more quickly in the modern double density system. Whatever format of disk is used, we always reserve two disk tracks for the CP/M operating system. This is slightly wasteful if you are using double sided drives and diskettes, because the present system would then actually fit on a single (double sided) track. However, as the amount of space wasted only costs a few pennies per diskette we have organised it this way because it gives the great benefit that just one universal version of SYSGEN (ie the version we supply) will suit single and double sided disks, and all diameters. If we were to have a different version for each set up sooner or later some user would use the wrong one and disaster would strike his data.

There are even greater benefits attached to the provision of the modified MOVCPM command. Unlike the standard Digital Research version supplied with most CP/M systems this modified version contains the correct (Interak) BIOS to suit the system in use. Now MOVCPM works exactly as Digital Research originally intended, and gives the outstanding benefit that the ordinary user can easily change the size of his CP/M for himself. This is why the present version is supplied in its 20K form which is the smallest size possible for Version 2.2 of CP/M; it can soon be altered by the user to suit himself.

Users of a serial system with 64K of RAM will undoubtedly change their system to 64K at once, but there are certain benefits to be had from a smaller system. Obviously if say a VDU-2K is in residence at address F000H the CP/M must be limited to 60K maximum, and there are other pressures for address space in a "work horse" type of system; for example space for EPROMs to reside in the memory space for programming or testing of firmware.

The memory on the new SBC-1 (single board computer) card is very conveniently tested during development by making a "hole" in the CP/M memory map or using MOVCPM. Another example would be during the development of say battery backed RAM boards or new types of refresh circuits for dynamic RAMs, even the testing of damaged RAM cards. Clearly the use of a 64K system would be most inappropriate in those special cases where a large proportion of the RAM was defective or undergoing development at the time.

The Skewtest program allows the best skew factor to be determined (since in this version the amount of skew is under the user's control), and the Formatter program allows the user to format all sizes of disks, single or double sided, single or double density.

Skewing

In case the concept of skewing is unfamiliar to you, here are a few words on the subject:

You will have gathered that the space on the disk is divided up into a number of concentric tracks, numbered for example from 0 (the outer track) to track 79 (the inner track). Several kilobytes of data can fit on a track and as the space on a disk is allocated and used dynamically whole tracks are inconveniently large; (for example if you changed "Mr Sinclair" to "Mr Sugar" during a word-processing session) it turns out to be too inefficient for the operating sustem (CP/M) to juggle whole tracks about to store this change.

Each track is therefore divided into smaller units, eg 512 byte "sectors" numbered from 1 to 10 on a typical small diskette. The obvious way to number the sectors, which was actually used in the early days of floppy diskettes, is, starting at the index hole, 1,2,3,4,5,6,7,8,9,10. The only trouble with this simple method is during the sequential access of several sectors. As the operating system gathers sector 1 and returns to find sector 2, the diskette of course has continued to turn - some other sector is under the drive head by now, and a wait of a whole disk revolution must be suffered, in fact 10 whole revolutions (an eternity in computer terms) to read all 10 sectors .

The first solution to this problem (before we arrived) was to fetch the sectors in some more suitable order, for example 1,4,7,10,3, and so on, if these are the sectors most likely to be in position when the operating system returns to read them. How then is a request for sectors 1,2,3,4,5 to be translated into a more optimum request for sectors 1,4,7,10,3? Not surprisingly the answer is a "Sector Translation Table", and facilities for this are built into CP/M. When a particular "logical" sector is to be accessed the table is consulted to determine what instead is the corresponding number of the "physical" sector. The jumps between adjacent sector numbers in the table is called the "Sector Skew" which is set at "3" in our example 1,4,7,10,3, etc.

Skew Factor

Although this first solution did solve the immediate problem it brought others in its wake. As computers get faster (for example as the 8080 gave way to the Z80, then the Z80A, next perhaps the HD 64180 "super Z80") the chosen skew becomes no longer optimum; the faster processors are forced to wait longer than they need when accessing multiple sectors. The consequent peril of changing the skew "factor" is that old and new diskettes become incompatible as the sector numbers are scrambled. In the case of the 8" IBM 3740 single density format diskettes, everyone, by common consent, uses a skew factor of 6, and this is the only format therefore which it is fairly safe to assume can be read by everyone (everyone who has 8" drives that is). Note that the sectors are not skewed in any way on the diskette, they are simply numbered 1,2,3,4,5, etc.; the skewing is carried out by a translation table within the operating system. This is the answer to anyone who bleats why can't there be a standard: there is; 8" single density, as described.

However the attractions of 3.5" 750K or more diskettes are irresistible and we, in common with many other manufacturers, have chosen a method of skewing which has more to commend it. The method is the simple one of abandoning the translation table entirely. In our adopted method sector 1 is always called sector 1, sector 2 is always sector 2 and so on. Instead of scrambling the sector numbers, we arrange that logically adjacent sector numbers are spaced physically on the track by the optimum amount. On the diskette itself sector 2 is found some suitable small distance away from sector 1, sector 3 is separated from sector 2, and so on. We call this "hard skewing", as distinct from the "soft skewing" produced by the sector translation table method, but another term we have heard is "sector interleaving".

Our formatting program allows you to vary the physical distance between logically adjacent sectors to achieve the optimum for your system at the time. (The additional utility program we provide, "SKEWTEST.COM" gives a method to determine the best skew to start with.) The great beauty of the method, which we stress involves no sector translation, is that diskettes recorded with different skews are equally legible to the unmodified operating system. The worst that can happen is that the disk system will run a little slower than it should if the skew factor is changed; this is infinitely preferable to having all your data turned into garbage - the consequence of changing the skew factor in the old method.

Rewards

Although this is fast turning into a tutorial instead of the advertising leaflet it was intended to be, there is one other matter which must be introduced. Originally there was only one side to a floppy diskette - the other side was only there to hold the first side together. Although it is quite a feat of engineering to design a double headed drive to be as reliable as a single headed drive, the rewards are worth it and we now (after a long period of legitimate mistrust) would recommend only double headed drives for a new installation. CP/M 2.2 does not allow for double sided diskettes directly but there are at least 3 techniques for implementing them.

The first method is so crude that it may be dismissed out of hand, since it manages to give the worst of all possible aspects. This is simply to treat the two surfaces of the diskettes as being equivalent to two entirely separate diskettes. This is very easy to implement and gives double sided operation without falling foul of the Trade Descriptions Act, but it still gives the same maximum diskette capacity per logical drive as would be obtained with single headed operation, and can leave you with the absurdity of having to discard a diskette as being "full" even when it may in truth be half empty.

80 Cylinders

The other two methods of achieving double sided working are more sensible. Remember that a diskette is divided into tracks and sectors, a typical diskette having 80 tracks each comprising 10 sectors of 512 bytes. A double sided diskette has this arrangement in duplicate, once on side "0" and again on side "1". When a double sided diskette is presented to CP/M, it obviously has twice the storage capacity of an equivalent single sided diskette. CP/M can be told either that the diskette now has double the number of tracks and the same number of sectors (ie 2 x 80 = 160 tracks of 10 sectors), or, that the same number of tracks and twice as many sectors (ie 80 tracks, 2 x 10 = 20 sectors).

Since the time taken to step from track to track, plus head settling time, is significantly longer than the time it takes to switch sides, the latter option is the one we favour. Of course we are now going to be in great danger of causing even more confusion - how many sectors are there per track: 10 or 20? To avoid this have borrowed a term from the bigger computer boys: the "cylinder", here equal to two tracks, one on each side of the diskette. One cylinder in this example has 20 512 byte sectors, ie 10K per cylinder.

No Pack Drill

This CP/M implementation has been carried out as neatly as possible (without losing its particular special features) and therefore allows a proper size TPA (Transient Program Area) for the user's programs to run in. Therefore there is more TPA in this implementation than one of nominally similar size implemented with less care. No names, no pack drill, but there is one popular computer about today which boasts 256K and more but still can't run standard applications programs which fit easily into the Interak TPA. Plenty of memory obviously sells computers but nobody seems to bother to check whether it can be used sensibly or not!

In order to achieve a large TPA we have decided that no expansion of error messages is to be carried out, but we think this will cause no hardship because in the usual Interak system operating system error messages should not be seen. Something is radically wrong if the system is unable to read from or write to a disk without error; who cares what on what track a faulty sector is located - it shouldn't be there! (Of course there are utility programs of the "Disk Doctor" type which can pinpoint such information if you do need it, but our feeling is that such medical matters are best not built into the basic structure of the operating system.)

For double density use great care has been taken with the "Deblocking Algorithm" and in this implementation disk transfers take place faster than any other implementation which we have tested.

Also in this system the I/O Byte has been implemented. This gives the following benefits:

CP/M "knows" only four logical peripherals: Console, Reader, Punch, List Device. The I/O byte assigns any one of the actual peripheral devices available to any of the four logical devices, in particular the Interak Cassette tape interface can be used as Punch and Reader.

Terminal-like

When the memory-mapped (VDU-2K) is in use, with both the DMON-M disk monitor EPROM and the BIOS within CP/M, the user can take advantage of an enhancement of the normal memory-mapped routines which drive such a VDU.

There are a number of commercial programs and programs from the "public domain" which could cause difficulty unless special action is taken in the BIOS. These assume that a serial type of VDU terminal is in use and send instructions to the terminal directly for such requirements as cursor positioning and switching to inverse video. The Interak BIOS contains additional code for use when the memory mapped VDU-2K is the system VDU, to make it behave like a serial terminal and so avoid problems of this nature. The following list gives details of terminal-like commands which the VDU-2K can then obey:

Hex.	Decimal	Meaning
08	08	Back-space (Cursor Left)
09	09	Tab
0A	10	Line Feed
0B	11	Cursor Up
0C	12	Cursor Right
0D	13	Carriage Return (Cursor to beginning of line)
1A	26	Clear Screen
1B	27	ESC (Escape), see table below
1E	30	Cursor Home (top left of screen)

Escape Sequences:

"ESC", "=", "<row>", "<col>" moves the cursor to the specified row and column (the row and column must have an offset of 20 hexadecimal added to them).
ESC 3, turns Inverse Video on (ie characters thenceforth will be black on white).
ESC 4, turns Inverse Video off (ie characters thenceforth will be white on black).

Status

There is a point which should be mentioned regarding the use of the present (LKP-1) parallel keyboard interface. It was designed to be compatible with an earlier non-Interak board (the Kemitron Electronics DCR-6) which occupied just one port in the system, and expected the software to take both the data, and the indication that these data were valid, in one single input (read) instruction. CP/M was designed with slower, serial, communications in mind, where the technique is that a status bit is tested by one routine, and an entirely separate routine reads the data.

The difference may appear to you to be so subtle that it is irrelevant to the finished performance of the system, however there are certain programs to run under CP/M which work far better with the serial arrangement. An example of such a program is "Wordstar", which is clever enough to appear capable of doing several things at once, for example printing one document while editing another. It does this by checking the keyboard status very regularly, noting when a key has been pressed, and then acting on that key later at its leisure.

This is not so easy with the present LKP-1 interface, since its single-port design demands that both status and data must be taken at once, and the action of reading the port automatically clears all bits to zero, ready for a new character. If the LKP-1 is in use, and if its characteristics when working with CP/M do become a problem, it is possible to alter either the hardware or the software, (or both). However we feel that it is best to leave such performance "tweaking" until after the system is up and running - it can be used without any modifications, so we suggest getting it running first and fine tune it later if you wish, after you have some experience with it.

CONTENTS OF PACKAGE

1 Digital Research 3-ring binder, usually A5 size.
1 Original Digital Research documentation (CP/M notes and instructions).
1 Digital Research licence agreement.
1 Digital Research update request and registration card.
1 Interak Master CP/M disk of specified size, ready to install.
1 Interak A4 4-ring binder.
1 Interak detailed installation notes, and discussion of CP/M as it relates to Interak.

ORDERING DETAILS

Whatever version is ordered the diskette supplied is set up for a 1-drive system, single sided disks, double density, 20K RAM. After copying the disk the user runs the "CONFIG" program and follows an installation procedure to set up the system he requires.

The preferred "Standard Interak Configuration" is 3.5", double sided, double density, 80 tracks per side, capacity 1 Megabyte per diskette (which becomes about 750K after formatting).

CPM8035	3.5"	80 tracks	10 sectors/track
	129.50 + VAT		
CPM805	5.25"	80 tracks	10 sectors/track
	129.50 + VAT		
CPM808	8"	77 tracks	15 sectors/track
	129.50 + VAT		

(There are many other less common or less desirable types of disk drive which this implementation of CP/M can accomodate, so if one of the above three varieties does not suit your particular disk drive, do not despair, but contact us for advice.)